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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
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00	Initial Issue. This document was previously issued using document identifiers BCA000000-01717-1705-00017 and BCA000000-01717-1705-00018. This document supersedes the previous issuances. This document is a complete rewrite of the superseded documents, driven largely by the use of an alternate source of regulatory requirements, the implementation of the License Application Design Selection effort, the use of a new document development procedure, and the combination of the waste emplacement and waste retrieval systems into a single system.
01	This revision to the document addresses changes to the system as a result of optimizing the Enhanced Design Alternative II for Site Recommendation, as well as changes to documents supporting Section 1. The contents of Section 1.4 has been removed as directed by management. This revision also adds Section 2.

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SUMMARY

The Emplacement Drift System is part of the Engineered Barrier System and provides the interface between the various waste package (WP) systems and the Ground Control System. In conjunction with the various WPs, the Emplacement Drift System limits the release and transport of radionuclides from the WP to the Natural Barrier following waste emplacement. Collectively, the Emplacement Drift System consists of the structural support hardware (emplacement drift invert and WP emplacement pallet) and any performance-enhancing barriers (drip shields and invert ballast) installed or placed in the emplacement drifts. The Emplacement Drift System is entirely located within the emplacement drifts in the subsurface portion of the Monitored Geologic Repository (MGR); specifically, it is physically bounded by the Subsurface Facility System, the Ground Support System, and the Natural Barrier. The Emplacement Drift System supports the key MGR functions of limiting radionuclide release to the Natural Barrier, minimizing the likelihood of a criticality external to the WPs, limiting natural and induced environmental effects, and providing WP support. The Emplacement Drift System limits radionuclide release to the Natural Barrier by controlling the movement of radionuclides within the emplacement drift and to the Natural Barrier, and by limiting water contact with the WPs. The Emplacement Drift System provides physical support and barriers for emplaced WPs that reduce water contact.

The Emplacement Drift WP spacing supports the thermal loading performance by complimenting drift layout and orientation as described in the system description document for the Subsurface Facility System. The Emplacement Drift System supports the WP and also provides an environment that aids in enhancing WP confinement performance.

As part of the Engineered Barrier System, the Emplacement Drift System interfaces with the WP systems. The Emplacement Drift System also interfaces with the Natural Barrier, Subsurface Facility System, and Ground Control System for the space and location of emplaced WPs, for the controlled release of radionuclides, and for controlling the heat, chemical, and physical effects that interact between these systems. The Emplacement Drift System interfaces with the Subsurface Ventilation System for preclosure heat removal from WPs. The Emplacement Drift System interfaces with the Waste Emplacement/Retrieval System and the Performance Confirmation Emplacement Drift Monitoring System for equipment clearance for the emplacement, retrieval, and monitoring of waste.

QUALITY ASSURANCE

The quality assurance (QA) program applies to the development of this document. The "SDD Development/Maintenance (Q SDDs) (WP# 16012126M5)" activity evaluation has determined the development of this document to be subject to "Quality Assurance Requirements and Description" requirements. This document was developed in accordance with AP-3.11Q, "Technical Reports."

1. SYSTEM FUNCTIONS AND DESIGN CRITERIA

The functions and design criteria for the system are identified in the following sections. Throughout this document the term "system" shall be used to indicate the Emplacement Drift System. The system architecture and classification are provided in Appendix B.

1.1 SYSTEM FUNCTIONS

1.1.1 The system contributes to the isolation of high-level waste from the Natural Barrier.

1.1.2 The system limits the likelihood of a self-sustainable fission reaction (external criticality) in both the near field and the far field.

1.1.3 The system limits the effect of rockfall on the WP.

1.1.4 The system provides a physical WP support for WPs within emplacement drifts.

1.1.5 The system influences the environment within emplacement drifts to protect WPs and the Natural Barrier.

1.1.6 The system limits the movement of radionuclides to the Natural Barrier upon WP breach.

1.1.7 The system limits microbial activity.

1.1.8 The system allows periodic inspection, testing, and maintenance of structures, systems, and components (SSCs) prior to permanent closure.

1.2 SYSTEM DESIGN CRITERIA

This section presents the design criteria for the system. Each criterion in this section has a corresponding Criterion Basis Statement in Appendix A that describes the need for the criterion as well as a basis for the performance parameters imposed by the criterion. Each criterion in this section also contains bracketed traces indicating traceability, as applicable, to the functions (F) in Section 1.1, the "Monitored Geologic Repository Requirements Document" (MGR RD), and "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada." In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as "10 CFR 63" in this system description document. For the applicable version of the codes, standards, and regulatory documents, refer to Appendix E.

1.2.1 System Performance Criteria

1.2.1.1 The system shall be designed such that when collectively assessed with the WPs and the natural barrier, the expected annual dose to the average member of the critical group[1] shall not exceed 0.25 mSv (25 mrem) total effective dose equivalent at any time during the first 10,000 years after permanent closure, as a result of radioactive materials released from the geologic repository.

[F 1.1.1][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.1.2 The system shall be designed to be capable of accommodating either 70,000 or 97,000 metric tons heavy metal (MTHM) or equivalent in a single design.[2]

[F 1.1.1][MGR RD 3.1.C, 3.2.A, 3.2.B, 3.2.P][10 CFR 63.113(b)]

1.2.1.3 The system shall be designed to provide for the addition of features and/or components that enable the system to accommodate 115,000 MTHM or equivalent.

[F 1.1.1]

1.2.1.4 The system shall limit the temperature of 50 percent of the pillar width to 96 degrees C or less (TBV-4629).

[F 1.1.5][MGR RD 3.1.C, 3.2.M, 3.2.N, 3.2.P][10 CFR 63.113(b)]

1.2.1.5 The system shall be designed to be closed as early as 30 years after emplacement of the last WP.

[MGR RD 3.2.H]

1.2.1.6 The system shall be designed for line loading of WPs within individual emplacement drifts, defined as a maximum heat load of 1.5 kW/m of emplacement drift, averaged over the entire emplacement drift at the time of completion of loading of the emplacement drift.

[F 1.1.5][MGR RD 3.1.C, 3.2.M, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.7 The system shall maintain a 15-m standoff distance between emplaced WPs and Type I faults, and a 5-m standoff distance between emplaced WPs and splays associated with Type I faults.

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.1.8 For 10,000 years, the system shall allow free-liquid-phase water, from the inflow identified in Table 1, to drain out of emplacement drifts, via the emplacement drift floor.

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[1] The critical group is defined in 10 CFR 63.115

[2] The 97,000 MTHM or equivalent design may be an augmentation of the 70,000 MHTM or equivalent design, and still be considered a single design.

Table 1. Emplacement Drift Inflow

Event Characteristic	Event Value
Water Volume	2 cubic meters per meter of emplacement drift (TBV-284)
Event Duration	1 week (TBV-284)
Event Frequency	1 event per year (TBV-284)

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.1.9 The invert structural members shall be composed of carbon steel.

[F 1.1.4, 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.1.10 The invert ballast shall maintain the pH of water within the ballast to between 6.7 (TBV-3881) and 10.2 (TBV-3881) for 10,000 years.

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.11 The invert ballast material shall be granular.

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.12 The drip shield shall have an operating life of 10,000 years.

[F 1.1.1, 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.13 The drip shield shall divert water dripping into the emplacement drift around the WP and to the drift floor.

[F 1.1.1, 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.14 The drip shield shall be designed to withstand a 6 metric ton (MT) (TBV-245) rock falling onto the top of the drip shield without rupturing the drip shield or parting between the individual drip shield units.

[F 1.1.1, 1.1.3, 1.1.5][MGR RD 3.1.C, 3.1.G, 3.2.P, 3.3.I][10 CFR 63.113(a), 63.113(b)]

1.2.1.15 The drip shield shall be designed to withstand a 6 MT (TBV-245) rock falling onto the top of the drip shield without the drip shield contacting a WP.

[F 1.1.1, 1.1.3, 1.1.5][MGR RD 3.1.C, 3.1.G, 3.2.P, 3.3.I][10 CFR 63.113(a), 63.113(b)]

1.2.1.16 The drip shield shall be designed to withstand an earthquake with an annual frequency of exceedance of 1 x 10^{-5} (TBV-4630) without rupturing or parting between individual drip shield units.

[F 1.1.1, 1.1.5][MGR RD 3.1.C, 3.1.G, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.17 The drip shield shall be designed to withstand an earthquake with an annual frequency of exceedance of 1 x 10^{-5} (TBV-4630) without contacting WPs after the earthquake.

[F 1.1.1, 1.1.5][MGR RD 3.1.C, 3.1.G, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.18 The drip shield materials shall be Grade 7 Titanium, and a minimum of 15-mm thick at the time of emplacement.

[F 1.1.1, 1.1.3, 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.1.19 Reserved

1.2.1.20 The invert and WP emplacement pallet shall maintain the WPs' nominal emplacement position for a minimum of 300 years.

[F 1.1.4][MGR RD 3.1.C, 3.1.G, 3.2.H][10 CFR 63.111(e)(1)]

1.2.1.21 The invert and WP emplacement pallet shall maintain the WPs' nominal horizontal emplacement position for 10,000 years after closure.

[F 1.1.4][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.1.22 The invert and WP emplacement pallet shall provide structural support for the SSCs as identified in Table 2.

Table 2. SSCs Supported by Invert and Pallet

SSC
Waste Packages
Drip Shields (invert only)
Backfill (invert only)
Waste Emplacement/Retrieval System mobile equipment (SSCs entering emplacement drifts, invert only)
Backfill Emplacement System mobile equipment (SSCs entering emplacement drifts, invert only)
Performance Confirmation Emplacement Drift Monitoring System mobile equipment (SSCs entering emplacement drifts invert only)
Subsurface Emplacement Transportation System (SSCs within emplacement drifts invert only)
Subsurface Excavation System (SSCs placing inverts, as necessary, invert only)

[F 1.1.4][MGR RD 3.1.C, 3.1.G, 3.2.C][10 CFR 63.111(e)(1)]

1.2.1.23 Lifting features of the WP Emplacement Pallet shall be designed for three times the maximum weight of the WP and pallet without generating a combined shear stress or maximum tensile stress in excess of the corresponding minimum tensile yield strength of the materials of construction.

[MGR RD 3.3.A]

1.2.1.24 Lifting features of the WP Emplacement Pallet shall be designed for five times the maximum weight of the WP and pallet without exceeding the ultimate tensile strength of the materials.

[MGR RD 3.3.A]

1.2.2 Safety Criteria

1.2.2.1 Nuclear Safety Criteria

1.2.2.1.1 The system shall permit all emplacement operations to be conducted such that WPs are lifted no higher than 2.4 m (TBV-245) above the invert.

[F 1.1.4]

1.2.2.1.2 For 10,000 years after permanent closure, any increase in radionuclide inventory due to all criticality events from fissionable material emplaced in the waste packages shall be less than 10 percent of the total radionuclide inventory available for release and transport to the accessible environment. (TBV-096)

[F 1.1.2][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(b)]

1.2.2.2 Non-nuclear Safety Criteria

1.2.2.2.1 The selection of invert ballast material shall consider the known health and safety hazards of the materials.

[F 1.1.4][MGR RD 3.3.A]

1.2.3 System Environment Criteria

1.2.3.1 The system shall limit the emplacement drift wall temperature to less than 200 degrees C (TBV-287).

[F 1.1.3, 1.1.5][MGR RD 3.1.C, 3.2.C, 3.2.M, 3.2.P][10 CFR 63.111(e)(1), 63.113(b)]

1.2.3.2 The system shall limit the temperature of zeolite layers located beneath the emplacement area horizon to less than 90 degrees C (TBV-286).

[F 1.1.5][MGR RD 3.1.C, 3.1.G, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.3.3 The system shall limit the change in temperature, at 45 cm below the soil surface, to 2 degrees C above what the established naturally occurring pre-emplacement average annual ground surface temperature is in the area directly above the emplaced WPs and extending 500 m beyond the edge of the emplaced WPs. (TBV-617)

[F 1.1.5][MGR RD 3.1.C, 3.2.F, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.3.4 The system shall limit the temperature of the PTn geologic unit to less than 96 degrees C (TBV-322).

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.3.5 The system shall be designed such that the differential uplift measured between the top of the TSw1 thermomechanical unit above the repository and the TSw1 thermomechanical unit at the preclosure controlled area boundary is less than 1 m (TBV-618).

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.3.6 The system shall be designed such that the differential uplift measured between the ground surface above the repository and the ground surface at the preclosure controlled area boundary is less than 0.5 cm/year (TBV-618).

[F 1.1.5][MGR RD 3.1.C, 3.2.P][10 CFR 63.113(a), 63.113(b)]

1.2.4 System Interfacing Criteria

1.2.4.1 Reserved

1.2.4.2 The system shall provide physical supports for WPs, as identified in Tables 3 and 4.

Table 3. 70,000 MTHM (or Equivalent) Emplacement Scenario

WP Type	WP Length (m)	Average Heat Output/WP (kW)	Maximum Quantity per WP Type*
21 PWR AP	5.17 (TBV-3298)	11.330	4500
21 PWR CR	5.17 (TBV-3298)	3.260	100
12 PWR AP Long	5.65 (TBV-3298)	8.970	170
44 BWR AP	5.17 (TBV-3298)	7.000	3000
24 BWR AP	5.11 (TBV-3298)	0.540	90
5 IPWF	3.59 (TBV-3298)	2.450	100
5 DHLW Short/1 DOE SNF Short	3.59 (TBV-3298)	2.575	1100
5 DHLW Long/1 DOE SNF Long	5.22 (TBV-3298)	2.575	1500
2 MCO/2 DHLW	5.22 (TBV-3298)	1.230	160
5 HLW Long/1 DOE SNF Short	5.22 (TBV-3298)	2.575	130
HLW Long Only	5.22 (TBV-3298)	2.450	600
Naval Short	5.43 (TBV-3298)	3.100	200
Naval Long	6.07 (TBV-3298)	3.100	100

See appendix C for definition of acronyms

Table 4. 97,000 MTHM (or Equivalent) Emplacement Scenario

WP Type	WP Length (m)	Average Heat Output/WP (kW)	Maximum Quantity per WP Type*
21 PWR AP	5.17 (TBV-3298)	11.330	5700
21 PWR CR	5.17 (TBV-3298)	3.260	110
12 PWR AP Long	5.65 (TBV-3298)	8.970	300
44 BWR AP	5.17 (TBV-3298)	7.000	3750
24 BWR AP	5.11 (TBV-3298)	0.540	100
5 IPWF	3.59 (TBV-3298)	2.450	130
5 DHLW Short/1 DOE SNF Short	3.59 (TBV-3298)	2.575	1410
5 DHLW Long/1 DOE SNF Long	5.22 (TBV-3298)	2.575	1880
2 MCO/2 DHLW	5.22 (TBV-3298)	1.230	200
5 HLW Long/1 DOE SNF Short	5.22 (TBV-3298)	2.575	170
HLW Long Only	5.22 (TBV-3298)	2.450	800
Naval Short	5.43 (TBV-3298)	3.100	200
Naval Long	6.07 (TBV-3298)	3.100	100

See appendix C for definition of acronyms

[F 1.1.4][MGR RD 3.3.A]

1.2.4.3 The system shall accommodate a WP maximum surface dose rate of 1410 rad/hr (TBV-248) for an intact WP at the time of emplacement.

[F 1.1.5][MGR RD 3.3.A]

1.2.4.4 The system shall accommodate a maximum WP thermal output of 11.8 kW at the time of emplacement.

[F 1.1.5][MGR RD 3.3.A]

1.2.4.5 The system shall accommodate removal of 70 percent of the heat generated by WPs by the Subsurface Ventilation System during the preclosure period.

[F 1.1.5][MGR RD 3.3.A]

1.2.4.6 The system shall provide for horizontal in-drift emplacement of WP Emplacement Pallets holding WPs within emplacement drifts by the Waste Emplacement/Retrieval System.

[F 1.1.4][MGR RD 3.3.A]

1.2.4.7 The system shall accommodate a minimum spacing of 10 cm between WPs within individual emplacement drifts.

[F 1.1.1, 1.1.4, 1.1.5][MGR RD 3.3.A]

1.2.4.8 The system shall accommodate a nominal spacing of 81 m between individual emplacement drifts.

[F 1.1.1, 1.1.5, 1.1.6][MGR RD 3.3.A]

1.2.4.9 The system shall accommodate a nominal emplacement drift excavated diameter of 5.5 m.

[F 1.1.1, 1.1.5][MGR RD 3.3.A]

1.2.4.10 Reserved

1.2.4.11 The system shall accommodate the mobile equipment operating and coupon placement envelopes identified in "Analysis of Clearance Envelopes for Emplacement Drift Operating Equipment and Space Envelopes for Test Coupons within the Emplacement Drift."

[F 1.1.8][MGR RD 3.3.A]

1.2.4.12 The materials that contact the surface of the WPs, as emplaced during the preclosure period, shall be the same material as the WP outer surface.

[F 1.1.4, 1.1.5][MGR RD 3.3.A]

1.2.4.13 The system shall accommodate an emplacement drift ground support system composed primarily of carbon steel (steel sets and/or rock bolts and mesh).

[F 1.1.5][MGR RD 3.3.A]

1.2.4.14 The system shall affect the emplacement drift environment such that WP near field environments of Table 5 are maintained.

Table 5. WP Near Field Environment

Environment	Range/Value
Temperature	(TBD-234)
Humidity	(TBD-234)
Microbial	10^14 microbes/year/m of emplacement drift (TBV-3881)
Colloidal	8 x 10^-6 (TBV-3881) to 6 x 10^-5 mg/ml (TBV-3881)
Water pH	6.7 (TBV-3881) to 10.2 (TBV-3881)
(TBD-234)	(TBD-234)

[F 1.1.5, 1.1.7][MGR RD 3.1.C, 3.2.M, 3.2.P, 3.3.A][10 CFR 63.113(a), 63.113(b)]

1.2.4.15 The system shall accommodate placement of the invert by the Subsurface Excavation System.

[F 1.1.4][MGR RD 3.3.A]

1.2.4.16 The system and all WPs emplaced within the system shall be located at least 200 m below the directly overlying ground surface. (TBV-619)

[MGR RD 3.1.C, 3.2.P, 3.3.C][10 CFR 63.113(a), 63.113(b)]

1.2.5 Operational Criteria

There are no operational criteria for this system at this time.

1.2.6 Codes and Standards Criteria

1.2.6.1 Design of steel SSCs shall be in accordance with "Manual of Steel Construction, Allowable Stress Design" or "Manual of Steel Construction, Load and Resistance Factor Design."

[MGR RD 3.1.G]

1.2.6.2 The system shall comply with the applicable assumptions contained in the "Monitored Geologic Repository Project Description Document."

1.3 SUBSYSTEM DESIGN CRITERIA

There are no subsystem design criteria for this system.

1.4 CONFORMANCE VERIFICATION

This section will be provided in a future revision.

2. DESIGN DESCRIPTION

Section 2 of this document summarizes information that is contained in other references. By assembling system specific information contained elsewhere (i.e., analyses, technical reports, etc.), Section 2 provides insight into the current state of the design of this system. However, due to the nature of design development, the information contained in this section will continue to change as the design matures.

2.1 SYSTEM DESIGN SUMMARY

The Emplacement Drift System, as part of the Engineered Barrier System, provides the interface between the various WP systems and the Ground Control System, and in conjunction with the WPs, limits the release and transport of radionuclides from the WP to the natural barrier. The Emplacement Drift System consists of the structural support hardware (emplacement drift invert and WP emplacement pallet) and any performance-enhancing barriers (backfill, if used, drip shields, and invert ballast) installed or placed in the emplacement drifts. This system also includes the thermal design of the repository. The system is entirely located within the emplacement drifts in the subsurface portion of the MGR.

2.1.1 Thermal Management

The thermal management of the subsurface repository is a major factor for postclosure performance of the repository. The design goal for the thermal loading strategy is for the heat generated by the waste in the repository not to cause boiling fronts to coalesce in the pillars between adjacent, loaded emplacement drifts. This goal aids in permitting water to be shed through the pillars during the postclosure thermal period.

The layout for Site Recommendation has been designed with an emplacement drift spacing of 81 m center-to-center and incorporates line loading of the WPs in the emplacement drifts. These design parameters, together with the WP inventories, result in an approximate areal mass loading of 56 metric tons of Uranium (MTU) per acre ("Site Recommendation Subsurface Layout," Sections 6.3.1 and 6.4.1).

2.1.2 Invert and Ballast

The invert is a carbon steel support frame located in the bottom of the emplacement drift, and is anchored to the tunnel wall. Ballast material is placed around the steel support frame up to the top of the frame. The invert provides support for the mobile equipment entering the emplacement drifts as well as the drip shield and WP/pallet combination emplaced in the drift, and the ballast may be employed as a performance-enhancing barrier.

2.1.3 Pallet

The emplacement pallets support the WP during emplacement. The emplacement pallets remain with the WP in the emplacement drift after emplacement and aid in preventing water from contacting the WP and in helping cool the WP by allowing for air circulation around it. Corrosion-resistant metals will be used for the emplacement pallets.

2.1.4 Drip Shield

A drip shield is a rigid structure that diverts water away from the WPs. Corrosion-resistant metals will be used for the drip shield. The drip shield increases the degree of defense in depth and protects the WP from contact with seepage water that is possibly chemically aggressive. The drip shield also reduces uncertainty by limiting the effects of rockfall on performance.

2.2 DESIGN ASSUMPTIONS

2.2.1 Thermal Management

The "ANSYS Thermal Calculations in Support of Waste Quantity, Mix and Throughput Study" (p. 19) was used as the primary source of information for the thermal analysis. This document used several assumptions that formed the basis for the calculation and are important to be recognized in the discussion of the thermal strategy.

The thermal calculation assumptions include the following:

- Emplacement drifts are located in the Tptpll geologic unit
- Spacing between the WPs is 10 cm
- Waste inventory is loaded into all of the emplacement drifts simultaneously
- Initial heat load is generated from the total inventory
- Representative emplacement drift in the model is 600 m in length

The ventilation duration period of 26 years describes the number of years that the last emplacement drift to be loaded with waste is subjected to continuous ventilation, assuming that the waste inventory is emplaced in 24 years and closure is at 50 years after initial waste emplacement.

2.2.2 Invert and Ballast

The assumptions used in the "Invert Configuration and Drip Shield Interface" are identified and explained in this section. Criterion 1.2.6.2 requires compliance with the applicable assumptions contained in the "Monitored Geologic Repository Project Description Document." The following Controlled Project Assumptions (CPAs) from the "Monitored Geologic Repository Project Description Document" have been used in the analysis.

2.2.2.1 Subsurface Configuration for Water Drainage

The repository subsurface layout will be configured for postclosure water drainage such that water entering the emplacement drifts can drain directly into the surrounding host rock without draining along the drift and without collection in a centralized location (this assumption does not encompass general flooding of the facility) ("Monitored Geologic Repository Project Description Document," CPA 026). This assumption is included in Criterion Basis Statement 1.2.1.8.
This assumption is addressed in "Invert Configuration and Drip Shield Interface" (Section 6.5, p. 33) by the requirements for evaluation of granular tuff to determine its function as a diffusive barrier. The granular tuff should have free flowing, non-adhering qualities and a hydraulic conductance (saturated or unsaturated), as determined by future analysis, capable of draining free-liquid-phase water out of the emplacement drifts via the emplacement drift floor for 10,000 years.

2.2.2.2 Enhanced Design Alternative II Design Definition for Performance Assessment Department, Waste Package Department, and Subsurface Facilities Department

Performance assessment modeling will use the design constraints in Section 5.0 of the "Monitored Geologic Repository Project Description Document" to define design concepts and parameters implementing Enhanced Design Alternative II. Performance assessment will assume that the design parameters are equal to values stated in these constraints and criteria as nominal or limiting values. ("Monitored Geologic Repository Project Description Document," CPA 039)

In addition, Performance Assessment Department, Waste Package Department, and Subsurface Facilities Department will assume, for Site Recommendation, that:

- The invert ballast material will be crushed tuff ("Monitored Geologic Repository Project Description Document," CPA 039).

- The free-standing drip shield is of "mailbox" shape and with uninterrupted coverage for the entire length of the emplacement drift ("Monitored Geologic Repository Project Description Document," CPA 039).

The first part of the assumption (ballast material) is in addition to Criterion 1.2.1.11 and defines the type of granular ballast material. The second part of the assumption identifies the extent of coverage the drip shields must provide, which defines the emplacement drift invert support and configuration that must be provided.

This assumption is addressed in "Invert Configuration and Drip Shield Interface" (Section 6.2, p. 16; Section 6.4, pp. 19 and 23; Section 6.5, pp. 32 and 34; and Section 7.1, p. 39).

2.2.3 Pallet

No Assumptions were used.

2.2.4 Drip Shield

The conceptual design of the drip shield is based on the "Monitored Geologic Repository Project Description Document" CPA 039. This assumption limits the drip shield design to a freestanding drip shield of "mailbox" shape that provides uninterrupted coverage for the entire length of the emplacement drift.

2.3 DETAILED DESIGN DESCRIPTION

2.3.1 Thermal Management

Two layouts were designed for Site Recommendation, a 70,000 MTU layout ("Site Recommendation Subsurface Layout," Section 6.3) and a 97,000 MTU layout ("Site Recommendation Subsurface Layout," Section 6.4). The layouts for Site Recommendation design do not preclude the accommodation of additional waste inventories up to 115,000 MTU.

The emplacement drifts are specified with an excavated diameter of 5.5 m and a center-to-center drift spacing of 81 m.

The layouts for Site Recommendation were developed consistent with the usable three-dimensional spatial boundaries within the geology of Yucca Mountain. The identified limits of the repository siting include limiting the emplacement area to within the characterized area and locating the emplacement level at least 200 m below the directly overly ground surface ("Site Recommendation Subsurface Layout," Section 6.2.2).

The emplacement drift average thermal load is calculated based on a 10 cm spacing between the WPs (a line loading of the WPs). The average thermal loads of the 70,000 MTU and 97,000 MTU cases is 1.42 kW/m and 1.43 kW/m, respectively ("Site Recommendation Subsurface Layout," Section 6.2.3.2). The average thermal load selected to determine the total length of emplacement drift in the Site Recommendation repository design has been approximated at 1.45 kW/m. The thermal load is averaged over a maximum emplacement drift split of 600 m (i.e., the length of a drift split is defined as the distance from the end of the emplacement drift to the ventilation raise, on each side of the repository block). These thermal loads are based on a WP inventory that must be controlled to produce a maximum thermal output of approximately 11.3 ± 0.5 kW to stay within the design criterion of 11.8 kW maximum WP thermal output at the time of emplacement ("Site Recommendation Subsurface Layout," Section 6.2.3.3).

A continuous ventilation flow rate of 15 m^3/s is sufficient to remove at 72 percent of the heat generated by the waste with 50 years of continuous ventilation ("Site Recommendation Subsurface Layout," Section 6.2.3.4). Only the first loaded emplacement drift will have a full preclosure ventilation period of 54 years. The last drift will only have 30 years of ventilation.

The thermal loading of the emplacement drifts were evaluated based on a 1.45 kW/m linear load with a continuous ventilation flow rate of 15 m^3/s. Under these conditions, it was determined that the emplacement drift walls would be maintained at a temperature of 96 degrees C or less during the preclosure period ("Site Recommendation Subsurface Layout," Section 6.2.3.5). As well, if the MGR is closed at 30 years after emplacement of the last WP, the temperature of 50 percent of the pillar width (the ¼ pillar) could be maintained at 96 degrees C or less ("Site Recommendation Subsurface Layout," Section 6.2.3.7), and the postclosure drift wall temperature would not exceed 200 degrees C ("Site Recommendation Subsurface Layout," Section 6.2.3.8).

Although specific analyses have not been completed, by inference it has been shown that the temperature of the zeolites should not exceed 90 degrees C and the temperature of the PTn geologic unit should not exceed 96 degrees C ("Site Recommendation Subsurface Layout," Section 6.2.3.10).

An analysis that was completed in support of the Viability Assessment, which determined thermally induced vertical deflection of the emplacement drift, was used to bound the potential uplift of the TSw1 geologic unit. It is expected that the ground deflection will not exceed the differential uplift limit or the differential uplift rate of the TSw1 geologic unit ("Site Recommendation Subsurface Layout," Sections 6.2.3.12 and 6.2.3.13).

The performance goal of maintaining the drift walls below 96 degrees C during the postclosure period ("Monitroed Geologic Repository Project Description Document, Section 5.1.5), which the design is not required to show compliance to, cannot be met with the current waste inventory, thermal loading strategy, and early closure of the MGR. The thermal evaluation of the emplacement drifts has shown that either the years of continuous ventilation must be increased or the thermal load decreased to ensure that the temperature of the emplacement drift walls is limited to 96 degrees C or lower during the postclosure period ("Site Recommendation Subsurface Layout," Section 6.2.3.6). With the current thermal load, the goal would be met only after approximately 175 years of preclosure ventilation ("Site Recommendation Subsurface Layout," Section 6.2.3.6).

2.3.2 Invert and Ballast

The emplacement drift invert consists of two major components, the carbon steel support frame and the granular crushed tuff ballast. The steel support frame is located in the bottom of the emplacement drift (i.e., the drift invert) and is anchored to the tunnel wall. Ballast material is placed around the steel support frame up to the top of the frame. Figure 1 shows an elevation of the steel invert with ballast and Figure 2 shows a perspective view.

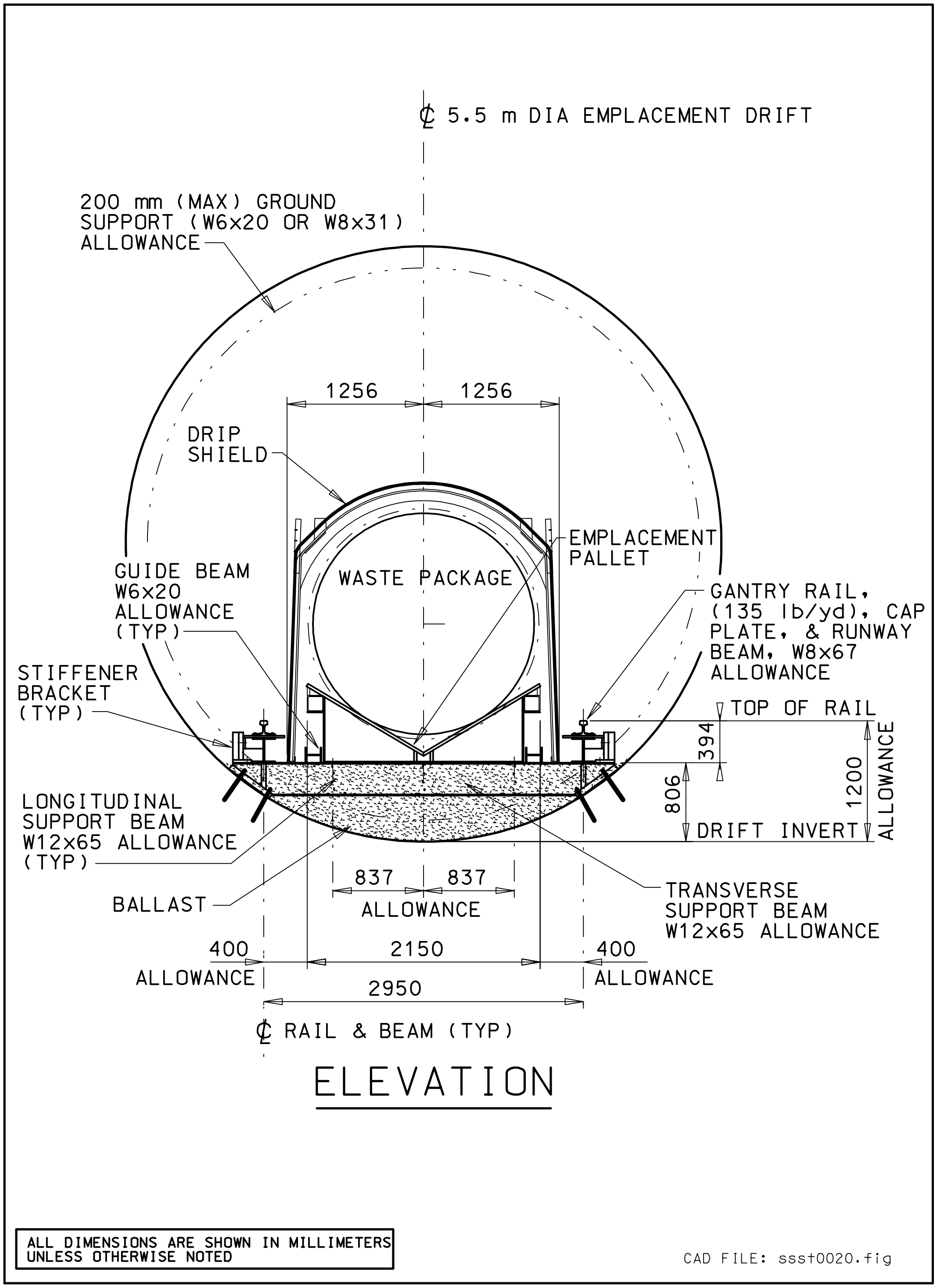

Figure 1. Emplacement Drift Invert-Elevation

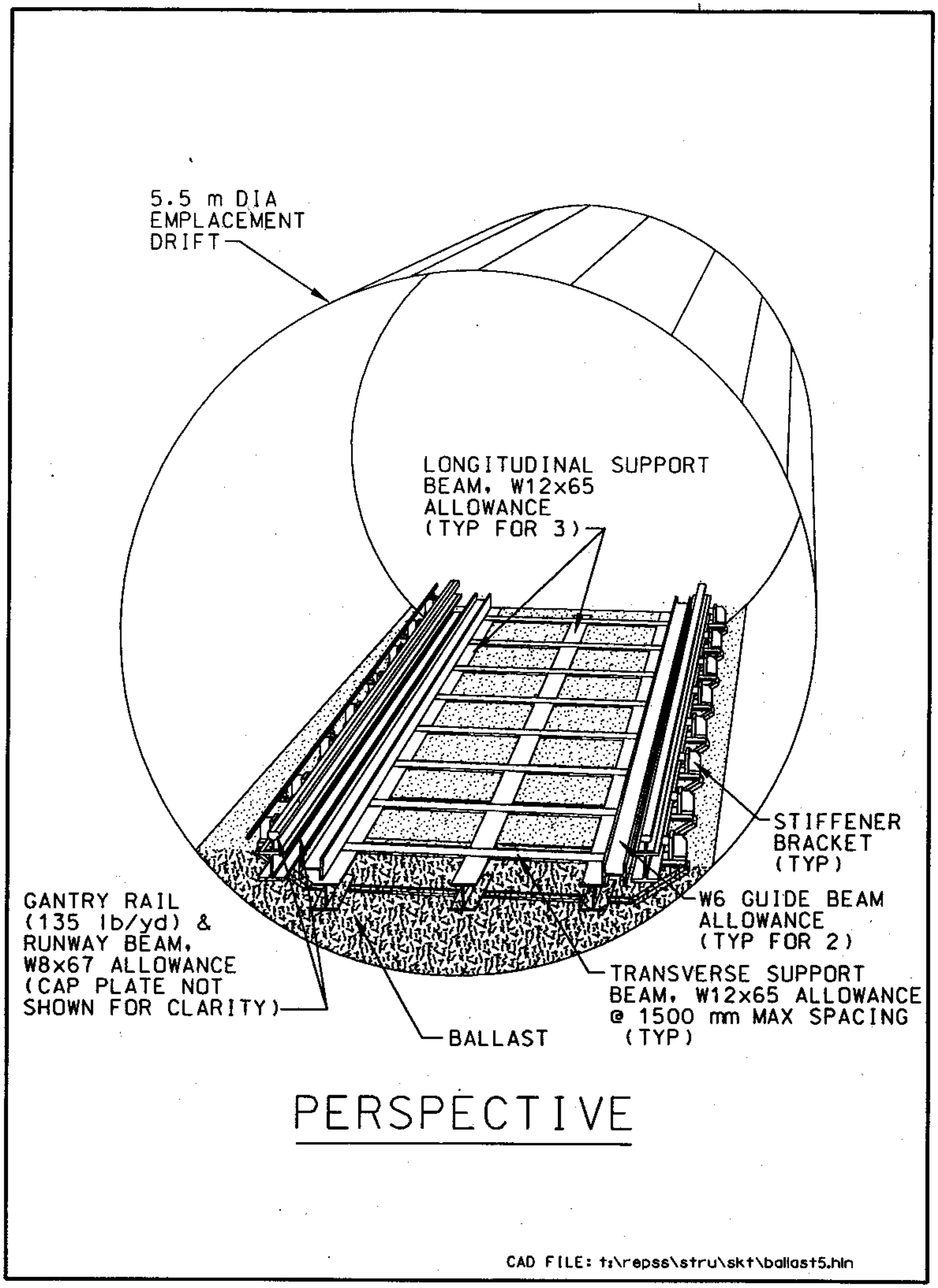

Figure 2. Emplacement Drift Invert-Perspective

The steel support frame consists of transverse and longitudinal beams bolted or welded together to provide a platform to continuously support the WP/pallet assemblies and the drip shields. The steel frame also supports a gantry rail and runway beam on each side of the frame to support the emplacement/retrieval equipment and monitoring equipment. Guide beams are also attached to the top of the steel frame to maintain the alignment of the emplacement pallets and the drip shields.

Transverse steel frame members are spaced at 1.5 m, as an allowance, to provide a spacing that coincides with the steel set ground support. The emplacement drift invert does not support any loads from the steel set ground support. The steel sets are continuous steel rings. The transverse steel beams are anchored to the tunnel walls with base plates to distribute the bearing loads. Rock bolts will be used to anchor the base plates to the tunnel walls.

Three longitudinal steel beams span between the transverse beams to provide continuous support along the drift for the WP/emplacement pallet assemblies. The longitudinal beams are spaced to provide edge and center support for the waste emplacement pallets. Length of the longitudinal beams will nominally meet the 1.5 m spacing between the transverse beams, but can be adjusted to accommodate the installation of steel ground support. Anchorage of the longitudinal beams to the transverse beams will be a combination of bolted and welded connections. The bolted connections will allow for the thermal expansion of the steel materials.

Guide beams, shown in Figures 1 and 2, will maintain the emplacement pallet alignment and keep the pallet from moving horizontally in the transverse direction. The guide beams will also provide alignment for the drip shields and keep the drip shields from contacting the WPs.

Runway beams are anchored near each end of the transverse beams to carry the gantry rail. The runway beam supports a steel cap plate to strengthen the runway beam section and to anchor the gantry rail. At each end of the transverse beam, a stiffener bracket is added to provide lateral support against overturning for the runway beam.

All structural steel is of ASTM A 572 materials (“Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel”). The rail is of ASTM A 759 material (“Standard Specification for Carbon Steel Crane Rails”).

Ballast material will be placed in the bottom of the invert and will be a granular crushed tuff. The tuff material will be placed and consolidated to establish a finished ballast surface that is near, but not greater than, the top of the invert steel. Analysis is required to determine the gradation for the ballast materials and to determine any potential diffusive properties that may be beneficial to the project.

Current invert design is conceptual and allowances for the sizes of the steel frame members has been made and are shown on Figures 1 and 2. Future analysis is required for the design of the steel frame beams, the beam and rail connections, the stiffener brackets, the beam stiffeners, and the fabrication details. Alignment criteria, horizontal and vertical, for the WP pallet assemblies and drip shields are also needed.

2.3.3 Pallet

The standard emplacement pallet (Figure 3) is designed to be compatible with all of the WP designs except for the WP containing short defense high-level waste canisters. This WP is much shorter than the rest of the WP designs, so it will require a shorter emplacement pallet.

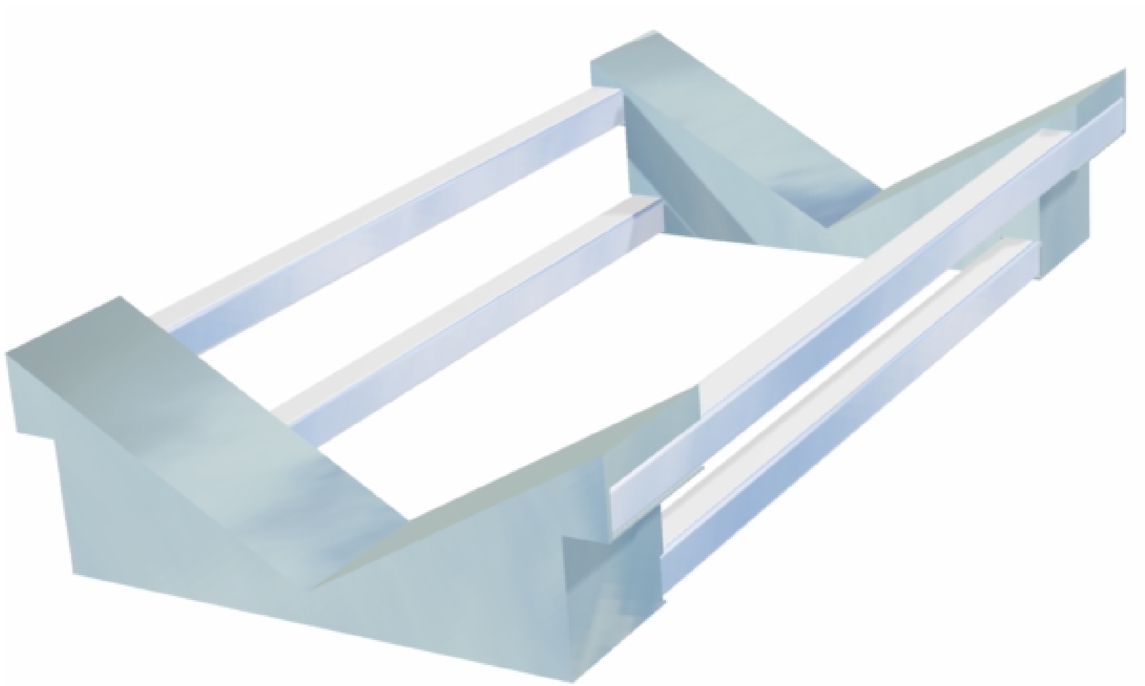

Figure 3. Emplacement Pallet Isometric View

The emplacement pallet supports are fabricated from Alloy 22 plates that are welded together. The two supports are connected by square stainless steel tubing to form the completed emplacement pallet. The supports have a V-groove top surface to accept all WP diameters. The pallet is shorter than the WPs, such that the WP will be supported on the outer barrier between the trunnion collar sleeves. The ends of the WP will extend past the ends of the emplacement pallet. The emplacement pallet will be used to transport the WP from the Waste Handling Building to the emplacement drift. The pallet will, therefore, be lifted while loaded with a WP. The lifting points are at the support, directly under the upper stainless steel tubes.

2.3.4 Drip Shield

The drip shield (Figure 4) is fabricated from titanium Grade 7 plates for long-term diversion of dripping water, titanium Grade 24 structural members for long-term structural support, and feet made of Alloy 22 to prevent direct contact between the

Figure 4. Drip Shield Isometric View

titanium and the steel members in the invert, which could result in hydrogen embrittlement of the titanium. All of the titanium components will be assembled by welding. The Alloy 22 feet will be connected by mechanical means since Alloy 22 and titanium cannot be welded together.

The drip shield sections will be uniformly sized, such that one design will be used over all waste package types. The drip shield sections will be interlocking to prevent separation between sections.

2.4 COMPONENT DESCRIPTION

No component descriptions are provided for this revision.

2.5 CRITERIA COMPLIANCE

This section compares applicable criteria with the system and component descriptions to show to what extent the criteria have been met and to identify criteria that need further proof. This comparison of system performance criteria, safety criteria, system environmental criteria, system interfacing criteria, operational criteria, and codes and standards criteria is detailed in Table 6.

Table 6. Criteria Compliance

Criterion	Adherence to Criteria
1.2.1.1	Criterion has been partially met in the "Invert Configuration and Drip Shield Interface" (Section 6.5, page 35). Ballast materials of crushed tuff and invert frame products of carbon steel when collectively assessed with the WPs and the natural barrier will not adversely impact the expected annual dose. Full demonstration of compliance with requirement is contingent upon the completion of the analysis of total system performance for site recommendation.
1.2.1.2	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.3.1 and 6.4.1). Subsurface layouts have been designed to accommodate up to 70,000 MTU and 97,000 MTU of waste.
1.2.1.3	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.5.1). The subsurface layout has been designed to allow an expansion of the subsurface layout to accommodate up to 115,000 MTU of waste.
1.2.1.4	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.2.3.7). The thermal evaluation of the emplacement drifts has shown that the quarter pillar temperature can be maintained below 96 degrees C.
1.2.1.5	This criterion can be met with successful compliance with the other driving thermal criteria limits ("Site Recommendation Subsurface Layout," Section 6.2.3.4 and 6.2.3.8).
1.2.1.6	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.2.3.2, 6.3.1, and 6.4.1) and "Design Analysis for Ex-Container Components" (Section 7.1.1). The WPs are line loaded in the emplacement drifts with an approximate linear thermal load of 1.45 kW/m. The thermal load is averaged over a maximum emplacement drift split of 600 meters (i.e., the length of a drift split is defined as the distance from the end of the emplacement drift to the ventilation raise, on each side of the repository block).
1.2.1.7	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.2.2.11). The subsurface facility does not intersect any Type I faults or splays associated with Type I faults and, therefore, a 15 meter standoff between WPs and Type I faults and a 5 meter standoff between WPs and splays of Type I faults is not used.
1.2.1.8	Criterion has been considered in the "Invert Configuration and Drip Shield Interface" (Section 6.5, page 33). Criteria is recommended for evaluating the granular tuff ballast material to ensure that the materials will allow the draining of free-liquid-phase water out of the emplacement drifts via the emplacement drift floor for 10,000 years for the drainage flows identified.
1.2.1.9	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Sections 6.2, page 16, 6.4, page 19, 6.5, page 32, and 7.1, page 39). The invert structural members are of carbon steel.
1.2.1.10	Criterion has been considered in the "Invert Configuration and Drip Shield Interface" (Section 6.5, page 32). Criterion recommended for evaluating invert ballast materials to ensure that the pH of water within the ballast is maintained between 6.7 and 10.2 for 10,000 years.
1.2.1.11	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Sections 6.2, page 16, 6.4, pages 19 and 23, 6.5, pages 32 and 34, and 7.1, page 39). The invert ballast materials are granular.
1.2.1.12	Demonstration of compliance with requirement is contingent upon the completion of the analysis of total system performance for site recommendation.
1.2.1.13	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.1).
1.2.1.14	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.1).
1.2.1.15	Compliance demonstrated, with minor modifications to the current design, in "Design Analysis for Ex-Container Components" (Section 7.1.1).
1.2.1.16	Seismic time histories have not been made available. Calculations will be performed at a later date. This criterion has not yet been evaluated.
1.2.1.17	Seismic time histories have not been made available. Calculations will be performed at a later date. This criterion has not yet been evaluated.
1.2.1.18	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.1).
1.2.1.20	Compliance demonstrated for static loading ("Design Analysis for Ex-Container Components," Section 7.1.1 and "Invert Configuration and Drip Shield Interface," Section 6.4, pages 26 and 29). Monitoring and necessary repair of the system will maintain the WPs' nominal emplacement position for a minimum of 300 years. Seismic loading to be performed at a later date.
1.2.1.21	Criterion has been considered in the "Invert Configuration and Drip Shield Interface" (Section 6.4, pages 26 and 29). Analysis is required to determine if the system will maintain the WPs' nominal emplacement position for 10,000 years after closure.

Table 6. Criteria Compliance (Continued)

1.2.1.22	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.4, pages 19, 23, 26, and 29) and in "Design Analysis for Ex-Container Components" (Section 7.1.1). Structural support is provided for the WPs, drip shields, backfill (if any), and emplacement/retrieval/monitoring equipment.
1.2.2.1.1	Criterion is met as shown by the conceptual design of the Waste Emplacement/Retrieval System, wherein the height that the WP pallet is lifted is restricted to 810 mm ("Bottom/Side Lift Gantry Conceptual Design," Section 6.3).
1.2.2.1.2	Compliance demonstrated for the evaluated waste form ("Design Analysis for Ex-Container Components," Section 7.1.2).
1.2.2.2.1	Criterion has been considered in the "Invert Configuration and Drip Shield Interface" (Section 6.5, page 33). Criterion recommended for the selection of ballast materials to ensure that known health and safety hazards of the materials are considered.
1.2.3.1	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.2.3.8). The thermal evaluation of the emplacement drifts has shown that the emplacement drift wall temperature can be maintained below 200 degrees C.
1.2.3.2	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.2.3.10). By inference, it has been shown that the temperatures of the zeolites should not exceed 90 degrees C.
1.2.3.3	This criterion has been discussed in the "Site Recommendation Subsurface Layout" (Section 6.2.3.11). At this time analyses have not been completed to show compliance with this criterion.
1.2.3.4	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.2.3.10). By inference, it has been shown that the temperatures of the PTn geologic unit should not exceed 96 degrees C.
1.2.3.5	This criterion has been discussed in the "Site Recommendation Subsurface Layout" (Section 6.2.3.12). It is expected that the ground deflection will not exceed the differential uplift limit in the TSw1 geologic unit.
1.2.3.6	This criterion has been discussed in the "Site Recommendation Subsurface Layout" (Section 6.2.3.13). Analyses have not been completed for confirmation of compliance with this criterion, but it is unlikely that the measurable uplift will be of concern.
1.2.4.2	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.4, pages 23, 29, and 32). Design of the invert and pallet is adaptable to the support for a minimum of 11,000 WPs.
1.2.4.3	This criterion has not yet been evaluated.
1.2.4.4	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.2.3.3), "Invert Configuration and Drip Shield Interface" (Section 6.5, page 35), and "Design Analysis for Ex-Container Components" (Section 7.1.4). The fuel inventory and WP loading must be controlled to produce a maximum thermal output of approximately 1.3 ± 0.5 kW to stay within the design criterion of 11.8 kW. Inherent thermal properties of the system materials can accommodate a maximum WP thermal output of 11.8 kW at the time of emplacement.
1.2.4.5	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.2.3.4). The thermal evaluation of the emplacement drifts has shown that the required heat removal is achieved prior to the earliest required repository closure date. Criterion has also been met in the "Invert Configuration and Drip Shield Interface" (6.4, p. 32). The invert design configuration reduces the emplacement drift cross section available for ventilation, however the Subsurface Ventilation System can be designed to accommodate the removal of 70 percent of the heat generated by WPs during the preclosure period.
1.2.4.6	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.4, p. 19) and "Design Analysis for Ex-Container Components" (Section 7.1.4). Invert design provides for horizontal in-drift emplacement of WP emplacement pallets holding WPs within emplacement drift by the Waste Emplacement/Retrieval Equipment.
1.2.4.7	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.4), "Invert Configuration and Drip Shield Interface" (Section 6.4, p. 19), and "Site Recommendation Subsurface Layout" (Section 6.2.3.2).
1.2.4.8	Criterion has been met in the "Site Recommendation Subsurface Layout" (Sections 6.2.1.2, 6.32.3.7, 6.3.1, and 6.4.1). The thermal evaluation of the emplacement drifts is based on spacing the emplacement drifts 81 m center-to center.
1.2.4.9	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.4), "Site Recommendation Subsurface Layout" (Section 6.2.1.2), and "Invert Configuration and Drip Shield Interface" (Section 6.4, page 19).
1.2.4.11	Criterion has been partially met in the "Invert Configuration and Drip Shield Interface" (Section 6.3, page 16). Design of the invert accommodated the mobile operating envelopes described. Full demonstration of compliance with this criterion will be performed for License Application.

Table 6. Criteria Compliance (Continued)

1.2.4.12	Compliance demonstrated in "Design Analysis for Ex-Container Components" (Section 7.1.4).
1.2.4.13	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.4, pages 23, 26, and 29). Design of the invert accommodates emplacement drift ground support of carbon steel sets and/or rock bolts and mesh.
1.2.4.14	The thermal analysis of the emplacement drifts did not include discussion of the emplacement drift environment since a thermal-hydrological analysis of the system has not yet been completed.
1.2.4.15	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.6, page 36). Handling of steel invert materials in the emplacement drift could be achieved by the use of rail mounted equipment operating on the Subsurface Excavation System construction access rail.
1.2.4.16	Criterion has been met in the "Site Recommendation Subsurface Layout" (Section 6.2.2). The identified limits for repository siting included limiting the emplacement area to at least 200 meters below the directly overlying ground surface.
1.2.6.1	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 6.4, pages 23 and 29). The appropriate manual of steel construction will be used in the structural analysis and design of the steel SSC's.
1.2.6.2	Criterion has been met in the "Invert Configuration and Drip Shield Interface" (Section 4.2.2, pages 10 and 11, and Section 4.3, pages 11 and 12) and "Design Analysis for Ex-Container Components" (Section 7.1.6).

3. SYSTEM OPERATIONS

A system operations description for this system will be provided in a future revision.

4. SYSTEM MAINTENANCE

A system maintenance description for this system will be provided in a future revision.

APPENDIX A CRITERION BASIS STATEMENTS

This section presents the criterion basis statements for criteria in Section 1.2. Descriptions of the traces to "Monitored Geologic Repository Requirements Document" (MGR RD) and "Revised Interim Guidance Pending Issuance of New U.S. Nuclear Regulatory Commission (NRC) Regulations (Revision 01, July 22, 1999), for Yucca Mountain, Nevada" are shown as applicable. In anticipation of the interim guidance being promulgated as a Code of Federal Regulations, it will be referred to as "10 CFR 63" in this system description document.

1.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to define the overall level of performance of the repository to which this system will be contributing. This criterion supports MGR RD 3.1.C, 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The performance parameters are taken from 10 CFR 63.113(b) and MGR RD 3.2.P.

1.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion sets the design capacity for the MGR and flows from MGR RD 3.2.A and MGR RD 3.2.B. It should be noted that this design capacity, along with the required drift spacing, WP spacing, and WP capacity, effectively fixes the areal mass loading of the repository. Since the areal mass loading plays a significant role in the overall performance of the repository, this criterion also supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The MGR waste design capacites are taken from "Monitored Geologic Repository Project Description Document," Section 5.1.4.1 and 5.1.4.2. These design capacities correspond to the design capacities of MGR RD 3.2.A and 3.2.B.

1.2.1.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure the repository design is not precluded from accommodating an expanded inventory, as required by the "Monitored Geologic Repository Project Description Document," Section 5.1.4.2.

II. Criterion Performance Parameter Basis

The expanded repository capacity is taken from the "Monitored Geologic Repository Project Description Document," Section 5.1.4.2.

1.2.1.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to enhance the ability of the repository to shed thermally mobilized water from the repository horizon. A section of host rock, between emplacement drifts, that is below the water boiling temperature is believed to allow drainage of thermally mobilized water above the repository horizon toward the water table, whereas a host rock entirely above the water boiling temperature would inhibit that flow of water.

This criterion supports MGR RD 3.1.C, 3.2.M, 3.2.N, and 3.2.P, and 10 CFR 63.113(b). This criterion also supports "Monitored Geologic Repository Project Description Document," Section 5.1.1.3.

II. Criterion Performance Parameter Basis

The temperature and rock mass limitations are taken from the "License Application Design Selection Report," p. O-15.

1.2.1.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to permit the repository to be closed early, if so directed, as required by MGR RD 3.2.H. This criterion also serves the intent of "Monitored Geologic Repository Project Description Document," Section 5.1.1.1, as indicated by "Change to Requirement 5.1.1.1 in Monitored Geologic Repository Project Description Document, Rev 01, DCN 01."

II. Criterion Performance Parameter Basis

The closure timing is taken from MGR RD 3.2.H.

1.2.1.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to produce a uniform temperature distribution along the axis of an individual emplacement drift. This criterion also has the added benefit of reducing the cost of excavation (the space between WPs is reduced [compared to advanced conceptual and viability assessment designs]; therefore, less emplacement drift length is needed) and emplacement drift construction materials (materials used for ground support, drip shields, inverts, etc., are reduced proportionally with emplacement drift length reduction).

Line loading of emplacement drifts is driven by "Monitored Geologic Repository Project Description Document," Section 5.2.10.

This criterion supports MGR RD 3.1.C, 3.2.M, and 3.2.P; and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The line loading parameters are taken from the "Monitored Geologic Repository Project Description Document," Section 5.2.10.

1.2.1.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the bounding fault standoff distance (i.e., the distance from any WP to the nearest fault) that protects the WPs from faults and splays (a minor fault that branches off of a larger fault) that represent potential preferential pathways.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The minimum distances between WPs and Type I faults and splays are taken from "Subsurface Facility System Description Document," Criterion Basis Statement 1.2.2.1.5.

1.2.1.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the system level of performance for draining free-liquid-phase water away from the emplacement drift to contribute to the long-term performance of WPs.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The water volume is taken from "Monitored Geologic Repository Project Description Document," CPA 040.

The 10,000-year timeframe is taken from 10 CFR 63.113(b).

1.2.1.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion reduces the uncertainties associated with emplacement drift radionuclide transport, as compared to the other primary invert material candidate (concrete).

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The invert material selection is obtained from "Monitored Geologic Repository Project Description Document," Section 5.2.8.

1.2.1.10 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish one function of the invert ballast, to control the pH of water transporting radionuclides.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The 10,000-year timeframe is taken from 10 CFR 63.113(b), and is corroborated by Table 4 of "Manager System Requirements/System Description Documents." The upper pH bound is obtained from Table 4 of "Manager System Requirements/System Description Documents" (Invert Barrier Requirements). The lower pH bound is obtained from Table I of "Groundwater Chemistry Along Flow Paths Between a Proposed Repository Site and the Accessible Environment."

1.2.1.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion reduces the uncertainties associated with emplacement drift radionuclide transport, as compared to the other primary invert material candidate (concrete).

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The invert ballast material selection is obtained from "Monitored Geologic Repository Project Description Document," Section 5.2.8.

1.2.1.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the drip shield is designed with an operating life long enough to achieve the functions allocated to it.

This criterion supports MGR RD 3.1.C, and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The 10,000 year timeframe is taken from 10 CFR 63.113(b), and is corroborated by the drip shield operating life in Table 4 of "Manager System Requirements/System Description Documents" (Drip Shield Barrier Requirements). The preliminary results transmitted in the "Manager System Requirements/System Description Documents" input transmittal indicate that additional performance is necessary over and above the 5,000 year life assigned to the drip shield in "Enclosure 2 - Guidelines for Implementation of EDA II," Section 9.0, which was transmitted by "Direction to Transition to Enhanced Design Alternative II" and baselined in "Interim Direction for Enhanced Design Alternative (EDA) II" (ECR No. E1999-0046).

1.2.1.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to protect the WP from dripping water during its operating life.

This criterion supports MGR RD 3.1.C, 3.2.P, 10 CFR 63.113(a), and 63.113(b).

II. Criterion Performance Parameter Basis

N/A

1.2.1.14 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish one of the required functions of the drip shield, to protect the WP from rockfall during its operating life.

This criterion supports MGR RD 3.1.C, 3.1.G, 3.2.P, 3.3.I, 10 CFR 63.113(a), and 63.113(b).

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

The rockfall parameter is taken from "Rock Fall Calculations for Drip Shield," Item 3.

1.2.1.15 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish one of the required functions of the drip shield, to protect the WP from rockfall during its operating life.

This criterion supports MGR RD 3.1.C, 3.1.G, 3.2.P, 3.3.I, 10 CFR 63.113(a) and 63.113(b).

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

The rockfall parameter is taken from "Rock Fall Calculations for Drip Shield," Item 3.

1.2.1.16 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to preserve the functionality of the drip shield after a design basis earthquake during its operating life.

This criterion supports MGR RD 3.1.C, 3.1.G, 3.2.P, 10 CFR 63.113(a), and 63.113(b).

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

The specification of the design earthquake for this criterion is made recognizing that the Category 2 preclosure design basis earthquake has a recurrence interval of 10,000 years, which would indicate a probability approaching unity that such an earthquake would occur during the postclosure period (assuming the probability of such an earthquake remains constant over the entire postclosure period). Specification of design earthquakes normally gives some margin over and above earthquakes expected to occur, thus specification of the Category 2 earthquake is inadequate for postclosure purposes. Specification of the design earthquake in this criterion gives a recurrence interval of 100,000 years, which is one order of magnitude higher than the earthquake expected to occur. This value will be used (as TBV) until a better substantiated value is provided.

1.2.1.17 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to preserve the functionality of the drip shield after a design basis earthquake during its operating life.

This criterion supports MGR RD 3.1.C, 3.1.G, and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

The specification of the design earthquake for this criterion is made recognizing that the Category 2 preclosure design basis earthquake has a recurrence interval of 10,000 years, which would indicate a probability approaching unity that such an earthquake would occur during the postclosure period (assuming the probability of such an earthquake remains constant over the entire postclosure period). Specification of design earthquakes normally gives some margin over and above earthquakes expected to occur, thus specification of the Category 2 earthquake is inadequate for postclosure purposes. Specification of the design earthquake in this criterion gives a recurrence interval of 100,000 years, which is one order of magnitude higher than the earthquake expected to occur. This value will be used (as TBV) until a better substantiated value is provided.

1.2.1.18 Criterion Basis Statement

I. Criterion Need Basis

This criterion is intended to ensure that the drip shield design will meet its other performance requirements.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The drip shield material and thickness is obtained from the "Monitored Geologic Repository Project Description Document," Section 5.2.11.

1.2.1.20 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the period of time that the system must physically support and maintain the WPs' as-emplaced position within an emplacement drift. The WP must be physically supported and maintained in the emplaced position to ensure that the emplacement, performance monitoring, possible retrieval, and closure activities can be performed with sufficient clearance around the emplaced WPs.

This criterion supports MGR RD 3.1.C, 3.1.G, 3.2.H, and 10 CFR 63.111(e)(1). This criterion also supports "Monitored Geologic Repository Project Description Document," Section 5.1.1.1.

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

The time period is derived from MGR RD 3.2.H.

1.2.1.21 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to designate the invert and pallet's postclosure WP support performance. Degradation of the invert and WP may occur, but horizontal movement of the WP must be minimized to ensure that the WP does not contact the drip shield. Contact between the drip shield and the WP has the potential to cause adverse reactions between the SSCs. This criterion supports MGR RD 3.1.C, 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The 10,000-year timeframe is taken from 10 CFR 63.113(b).

1.2.1.22 Criterion Basis Statement

I. Criterion Need Basis

This criterion is necessary to ensure that the invert will be able to withstand its anticipated loading and still function to support WPs, performance-enhancing barriers, and emplacement and retrieval operations.

This criterion supports MGR RD 3.1.C, 3.1.G, 3.2.C, and 10 CFR 63.111(e)(1).

Backfill and the Backfill Emplacement System are included as a component to be included as a load, even though backfill is not part of the current design, because inclusion of these loads supports the physical installation of backfill, as required by the "Monitored Geologic Repository Project Description Document," Section 5.2.9.

This criterion is supported by guidance contained in the "Compliance Program Guidance Package for Ex-Container System," Guidance Statements 6.7g1 and 6.9g1.

II. Criterion Performance Parameter Basis

N/A

1.2.1.23 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the WP is able to be safely lifted by the Waste Emplacement/Retrieval System. With the addition of the emplacement pallet to the reference design for Site Recommendation, the pallet assumed the responsibility for the lifting of the WP within the emplacement drift by the emplacement/retrieval gantry. This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of the "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More" (ANSI N14.6-1993).

1.2.1.24 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the WP is able to be safely lifted by the Waste Emplacement/Retrieval System. With the addition of the emplacement pallet to the reference design for Site Recommendation, the pallet assumed the responsibility for the lifting of the WP within the emplacement drift by the emplacement/retrieval gantry. This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The factors-of-safety are obtained from Section 4.2.1.1 of the "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More" (ANSI N14.6-1993).

1.2.2.1.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to implement a portion of the safety strategy as described in "Decision Package Executive Summary, Strategy to Mitigate Preclosure Offsite Exposure," Description V of Options 1 and 2. The executive summary is an attachment to "Strategy to Mitigate Preclosure Offsite Exposure." A portion of that safety strategy is to not lift the WP above its design basis height. Lifts above the design basis drop height could result in a WP breach and subsequent exposure if dropped. This criterion will ensure that the emplacement hardware, primarily the WP pedestal, is not designed such that emplacement equipment is forced to lift the WP higher than its design basis drop height.

II. Criterion Performance Parameter Basis

The lift height value is taken from "Waste Package Design Basis Events," Table 8-1. Implicit in the value identified is the concept that WPs will be emplaced in a horizontal position, which is consistent with the current design. In addition, the lift height value is identical to the horizontally-oriented drop height criterion baselined in the system description documents for the various disposal containers.

1.2.2.1.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the consequences of postclosure criticality events do not cause the repository to exceed the postclosure performance requirement of MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(b).

II. Criterion Performance Parameter Basis

The timeframe used for the 10,000-year criticality control period is taken from 10 CFR 63.113(b).

The performance parameter for this criterion is chosen to implement the methodology of the "Disposal Criticality Analysis Methodology Topical Report" and be consistent with the criticality criteria for the disposal containers. The performance parameter basis for this criterion ensures criticality occurrences in the repository will not invalidate the total system performance assessment of expected annual dose to the critical group during the criticality control period. The 10 percent inventory increase is taken from the intermediate risk criterion of "Disposal Criticality Analysis Methodology Topical Report," Section 3.6.3, and is such that the intermediate criticality risk is less is less than the uncertainty in the total system performance assessment calculation of expected annual dose to the critical group.

Available for release (as used in the criterion) is defined in "Disposal Criticality Analysis Methodology Topical Report," Section 3.6.3, as radionuclide inventory from waste packages that have breached barriers and the waste form that have degraded sufficiently to expose the radionuclides to dissolving water.

1.2.2.2.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that health and safety issues related to placement of the invert ballast materials are considered in the design.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.3.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the maximum temperature of the drift wall to limit the thermomechanical response of the host rock. Excessive near field temperatures (temperatures in excess of the temperature limit for this criterion) could result in local rock failure, which could make retrieval difficult during the preclosure period, and could have the potential to degrade the system's performance during the postclosure period. High temperatures (above the temperature limit for this criterion) can also create significant differential stresses between the drift wall rock and the drift wall ground support. This concern is described in detail in "Thermal Loading Study for FY 1996," Section 3.3.

This criterion supports MGR RD 3.1.C, 3.2.C, 3.2.M, and 3.2.P; and 10 CFR 63.111(e)(1) and 63.113(b).

II. Criterion Performance Parameter Basis

The thermal limit value is taken from the recommendations given in "Thermal Loading Study for FY 1996" in Sections 3.3.3 and 7.

1.2.3.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to preserve the ability of the zeolite layer beneath the emplacement area to act as a natural barrier to radionuclide migration. Temperatures above 90 to 100 degrees C may potentially alter the zeolite (e.g. clinoptilolite) layer to analcime, which has much poorer sorption properties for radionuclides than does clinoptilolite, as discussed in "Thermal Loading Study for FY 1996," Section 3.2.4.

This criterion also supports MGR RD 3.1.C, 3.1.G, 3.2.P, 10 CFR 63.113(a), and 63.113(b).

II. Criterion Performance Parameter Basis

The zeolite temperature limit is taken from "Thermal Loading Study for FY 1996," Section 7.

1.2.3.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the bounds for limiting the temperature of the soil surface above the emplaced WPs and just below the soil surface. Soil temperature limits are necessary to limit the environmental impacts at the surface and reduce the potential for adverse changes to the geologic structures, which might increase water infiltration toward the repository emplacement structure.

This criterion supports MGR RD 3.1.C, 3.2.F, 3.2.P, 10 CFR 63.113(a), and 63.113(b).

II. Criterion Performance Parameter Basis

The thermal bound on the soil temperature is provided by MGR RD 3.2.F.

1.2.3.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to bound the temperature limits of the PTn geologic unit to limit the thermal, thermomechanical, and thermochemical response of the host rock. The effects of temperature changes in the PTn geologic unit have not been fully studied; however, it is speculated in the “Site Characterization Plan Thermal Goals Reevaluation,” pp. 18 and 19, that the PTn could limit the amount of infiltrating water that could readily percolate to the repository horizon, and could act as a barrier against the release of radioactive carbon gas emanating from a breached WP.

This criterion supports MGR RD 3.1.C, 3.2.P, 10 CFR 63.113(a), and 63.113(b).

II. Criterion Performance Parameter Basis

Although a PTn temperature limit is recommended in the “Site Characterization Plan Thermal Goals Reevaluation,” p. 21 (recommendation 16), no quantitative limit is established as part of the recommendation. However, it is suggested on p.19 of the same document that an appropriate temperature limit for the PTn could be the boiling point of water. That suggestion forms the basis for establishing the 96 degrees C temperature limit in this criterion.

1.2.3.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to preserve the integrity of the natural barrier, as discussed in the 'Assessment of Goals' section (p. 10) of the “Site Characterization Plan Thermal Goals Reevaluation.” The following discussion is paraphrased from that document. The potential repository will initially be surrounded by relatively undisturbed rock formations. After waste emplacement begins, the repository will locally heat up and expand. If this expansion is sufficient, this can result in large horizontal stresses developing in the far field and an uplift in the repository region. If this uplift is large enough, it could cause the rock above the repository, especially the non-welded PTn units, to extend, resulting in fracturing of the units. This would damage the principal natural barrier above the potential repository, and could result in the opening of preferential pathways for water infiltration, or pathways for gas migration.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The thermomechanical unit uplift value for the TSw1 is taken from recommendation 3 listed in the 'Summary and Recommendations' section (p. 20) of the "Site Characterization Plan Thermal Goals Reevaluation."

1.2.3.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to preserve the integrity of the natural barrier, as discussed in the 'Assessment of Goals' section (p. 10) of the "Site Characterization Plan Thermal Goals Reevaluation." The following discussion is paraphrased from that document. The potential repository will initially be surrounded by relatively undisturbed rock formations. After waste emplacement begins, the repository will locally heat up and expand. If this expansion is sufficient, this can result in large horizontal stresses developing in the far field and an uplift in the repository region. If this uplift is large enough, it could cause the rock above the repository, especially the non-welded PTn units, to extend, resulting in fracturing of the units. This would damage the principal natural barrier above the potential repository, and could result in the opening of preferential pathways for water infiltration, or pathways for gas migration.

This criterion supports MGR RD 3.1.C and 3.2.P, and 10 CFR 63.113(a) and 63.113(b).

II. Criterion Performance Parameter Basis

The ground surface uplift rate above the repository is taken from recommendation 4 listed in the 'Summary and Recommendations' section (p. 20) of the "Site Characterization Plan Thermal Goals Reevaluation."

1.2.4.2 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the characteristics of WPs to be emplaced within the system.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The WP characteristics are obtained from the "Monitored Geologic Repository Project Description Document," Sections 5.2.3 and 5.2.4.

The quantities of the waste packages for the Naval short canisters and the Naval long canisters come from Sections 5.1.4.1 and 5.1.4.2 of the "Monitored Geologic Repository Project Description Document." The Navy's position is that the maximum number of Naval short canisters is 200 and the maximum number of Naval long canisters is 100. The additional quantities provided in Sections 5.2.3 and 5.2.4 is not necessary for the Naval canisters. This Navy position is corroborated in "Information Requested by the Yucca Mountain Site Characterization Office For Use in the Repository Environmental Impact Statement."

The WP lengths are taken from "Revised Waste Package Lengths," Item 1.

1.2.4.3 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to identify the maximum surface dose rate to be expected at the WP surface. Radiation fields have the potential to change the physical properties of materials and to alter physical processes over time.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The surface dose rate is obtained from "Dose Rate Calculation for the 44-BWR UCF Waste Package," Table 25. The results from the calculation are conservatively converted from rem/hr to rad/hr and rounded up to the nearest 10 rad/hr for use in this system's design.

1.2.4.4 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface between this system and emplaced WPs. Maximum WP thermal output affects the thermal limitations placed on this system.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The WP maximum thermal output is obtained from "Monitored Geologic Repository Project Description Document," Section 5.2.13.

1.2.4.5 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface between this system and the Subsurface Ventilation System. Removal of WP decay heat by the ventilation system affects the thermal limitations placed on this system.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The WP heat removal percentage and timeframe is obtained from "Monitored Geologic Repository Project Description Document," Section 5.1.3.1.

1.2.4.6 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface with the Waste Emplacement/Retrieval System. Horizontal in-drift emplacement also affects the design of the Performance Confirmation Emplacement Drift Monitoring System and the Backfill Emplacement System.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.4.7 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface between this system and the Waste Emplacement/Retrieval System. This criterion is a quantification of the criterion to line load the WPs.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The WP spacing is obtained from "Monitored Geologic Repository Project Description Document," Section 5.2.10.

1.2.4.8 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface with the Subsurface Facility System. Drift spacing affects the thermal limitations placed on this system. This criterion is a quantification of the criterion to preclude the merging of the pore water boiling fronts between individual emplacement drifts. This spacing is also intended to reduce the influence of one emplacement drift on another (as compared to subsurface facility designs with more closely spaced emplacement drifts).

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The drift spacing is obtained from “Monitored Geologic Repository Project Description Document,” Section 5.2.1.

1.2.4.9 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface with the Subsurface Facility System. The excavated drift diameter affects the thermal limitations placed on this system.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The drift spacing is obtained from “Monitored Geologic Repository Project Description Document,” Section 5.2.5.

1.2.4.11 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to establish the requirements for bounding the physical envelope available to the system, as an interface with the emplaced WPs, Ground Control System, Waste Emplacement/Retrieval System, Backfill Emplacement System, and the Performance Confirmation Emplacement Drift Monitoring System.

This criterion supports MGR RD 3.3.A, and “Monitored Geologic Repository Project Description Document,” Section 5.2.9.

II. Criterion Performance Parameter Basis

N/A

1.2.4.12 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the WP supports do not result in an adverse interaction between the WP outer barrier material and the support materials. In addition, it ensures that the SSCs that contact the WP will withstand the maximum WP external temperature.

The "Monitored Geologic Repository Project Description Document" constrains the disposal container design to use Alloy 22 for the outer barrier of the disposal container (Section 5.2.12). The emplacement of WPs on supports results in intimate contact between the WP outer barrier and the supports, and these areas of contact are potential crevice corrosion locations. As the relative humidity in the drift increases, galvanic reactions may take place in the crevice locations. When a corrosion resistant material (such as Alloy 22) is in contact with a less noble material (such as carbon steel), active corrosion of the carbon steel could occur generating hydrogen. This could potentially charge hydrogen into the nickel base alloys causing embrittlement of the WP outer barrier ("Metals Handbook," Volume 13 [Corrosion], p. 652). It is therefore important that dissimilar metal contacts at the WP surface are avoided. The WP support surfaces contacting the WP outer barrier should be fabricated from the same material as the WP outer barrier.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.4.13 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed as an interface with the Ground Control System. The use of concrete as the primary ground support material can have significant affects on the pH of water entering an emplacement drift. Elimination of concrete as the primary ground support material relieves the system (some portions of which are tasked to control the pH of water within emplacement drifts) of the need to compensate for substantial amounts of concrete in the emplacement drifts.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

The ground support material is obtained from "Monitored Geologic Repository Project Description Document," Section 5.2.6.

1.2.4.14 Criterion Basis Statement

I. Criterion Need Basis

This criterion maintains the near field environment interface between the system and the emplaced WPs. The system design determines many of the emplacement drift environment variables for which the disposal container will have to be designed.

This criterion supports MGR RD 3.1.C, 3.2.M, 3.2.P, and 3.3.A; and 10 CFR 63.113(a), and 63.113(b).

II. Criterion Performance Parameter Basis

Environment parameters, with the exception of the lower pH bound, are obtained from Table 4 of “Manager System Requirements/System Description Documents.”

The lower pH bound is obtained from Table I of “Groundwater Chemistry Along Flow Paths Between a Proposed Repository Site and the Accessible Environment.”

1.2.4.15 Criterion Basis Statement

I. Criterion Need Basis

This criterion is needed to ensure that the design of the inverts includes consideration for the constructability of the inverts, such as loads placed on the inverts by the Subsurface Excavation System as the inverts are placed.

This criterion supports MGR RD 3.3.A.

II. Criterion Performance Parameter Basis

N/A

1.2.4.16 Criterion Basis Statement

I. Criterion Need Basis

This criterion responds directly to MGR RD 3.3.C and supports MGR RD 3.1.C, 3.2.P, 10 CFR 63.113(a), and 63.113(b). This criterion is intended to be met in conjunction with a similar criterion levied upon the Subsurface Facility System.

II. Criterion Performance Parameter Basis

The overburden depth is taken from MGR RD 3.3.C.

1.2.6.1 Criterion Basis Statement

I. Criterion Need Basis

This criterion ensures that the design complies with “Manual of Steel Construction, Allowable Stress Design” or “Manual of Steel Construction, Load and Resistance Factor Design.”

This criterion supports MGR RD 3.1.G, and is supported by guidance contained in the “Compliance Program Guidance Package for Ex-Container System,” Guidance Statements 6.7g1, 6.9g1, 7.1g1, and 7.2g1.

II. Criterion Performance Parameter Basis

N/A

1.2.6.2 Criterion Basis Statement

I. Criterion Need Basis

The “Monitored Geologic Repository Project Description Document” allocates controlled project assumptions to systems. This criterion identifies the need to comply with the applicable assumptions identified in the subject document. The approved assumptions will provide a consistent basis for continuing the system design.

II. Criterion Performance Parameter Basis

N/A

APPENDIX B ARCHITECTURE AND CLASSIFICATION

The system architecture and QA classification are identified in Table 7. The QA classifications are established in "Classification of the Emplacement Drift System".

Table 7. System Architecture and QA Classification

Emplacement Drift System	QL-1	QL-2	QL-3	CQ
Invert	X			
Drip Shield	X			
Backfill (if used)	X			
WP Emplacement Pallet	X			

APPENDIX C ACRONYMS, SYMBOLS, AND UNITS

C.1 ACRONYMS

This section provides a listing of acronyms used in this document.

BWR AP	boiling water reactor absorber plates
CPA	Controlled Project Assumption
CQ	conventional quality
DHLW	defense high-level waste
DOE	U.S. Department of Energy
F	function
HLW	high-level waste
IPWF	immobilized plutonium waste form
MCO	multi-canister overpack
MGR RD	Monitored Geologic Repository Requirements Document
MGR	Monitored Geologic Repository
N/A	not applicable
PWR AP	pressurized water reactor absorber plates
PWR CR	pressurized water reactor control rods
QA	quality assurance
QL	quality level
SNF	spent nuclear fuel
SSCs	structures, systems, and components
TBD	to be determined
TBV	to be verified
WP	waste package

C.2 SYMBOLS AND UNITS

This section provides a listing of symbols and units used in this document.

°	degree
%	percent
±	plus or minus
C	Celsius
cm	centimeters
hr	hour
kW	kilowatt
lb	pounds
m	meters
mg	milligram
ml	milliliter
mm	millimeter
mrem	milli-Roentgen equivalent man
mSv	millisievert
MT	metric ton
MTHM	metric tons heavy metal

MTU	metric tons of Uranium
pH	potential of hydrogen
PTn	Paintbrush tuff nonwelded
rad	radiation absorbed dose
rem	roentgen equivalent man
s	second
Tptpll	Topopah Spring Tuff crystal poor lower lithophysal zone
TSw1	Topopah Spring welded unit 1-lithophysal rich
yd	yard

APPENDIX D FUTURE REVISION RECOMMENDATIONS AND ISSUES

This appendix identifies issues and actions that require further evaluation. The disposition of these issues and actions could alter the functions and design criteria that are allocated to this system in future revisions to this document. However, the issues and actions identified in this appendix do not require TBDs or TBVs beyond those already identified.

There are no future revision recommendations or issues at this time.

APPENDIX E REFERENCES

This section provides a listing of references used in this document. References list the Accession number or Technical Information Catalog number at the end of the reference, where applicable.

"American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More." American National Standards Institute. ANSI N14.6-1993. 1993. New York, New York: American National Standards Institute. TIC: 236261.

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